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# High-Resolution Anorectal Manometry – New Insights in the Diagnostic Assessment of Functional Anorectal Disorders

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**Keywords**

Functional anorectal disorders · High-resolution anorectal manometry · Dyssyngergic defecation · Faecal incontinence

**Summary**

Functional anorectal disorders such as faecal incontinence (FI), functional anorectal pain, and functional defecation disorders (FDD) are highly prevalent and represent a high socioeconomic burden. Several tests of anorectal function exist in this setting; however, high-resolution anorectal manometry (HR-ARM) is a new tool that depicts pressure all along the anal canal and can assess rectoanal coordination. HR-ARM is used in the diagnosis of FI and especially FDD although data in health is still sparse, and pressure phenomena seen during simulated defecation, such as dyssynergia, are highly prevalent in health.



## Introduction

Functional anorectal disorders comprise faecal incontinence (FI), functional anorectal pain, and functional defecation disorders (FDD), including dyssynergic defecation (DD) and inadequate propulsion according to the new Rome IV criteria [1]. Functional anorectal pain is subdivided into levator ani syndrome, unspecified anorectal pain, and proctalgia fugax. The definitions of these conditions are based on symptoms and, in the case of FI and FDD, in part on physiological testing. FDD are diagnosed when more than two symptoms of chronic constipation or irritable bowel syndrome (IBS) and more than two parameters of impaired evacuation, i.e. dyssynergic manometry patterns, impaired evacuation on imaging, or failed balloon expulsion test (BET), are present. Functional anorectal disorders are highly prevalent and have a significant impact on quality of life. Symptoms are often not mentioned by patients due to perceived social stigma [2–5]. Doctors often do not screen for anorectal dysfunction, which remains a significant economic and medical challenge [6–9].

Various tests are available to investigate anorectal function; for FI and FDD, however, anorectal manometry (ARM) is the most commonly performed, accepted, and best established investigation [10–12]. ARM assesses the pressure in the anal canal at rest and during voluntary effort (squeeze) as well as attempted evacuation (simulated defecation). Pressures in the anal canal and rectum are either presented as line traces (conventional manometry) or as colour-contour plots (high-resolution manometry (HRM)). Both water-perfused and solid-state catheters are used in clinical practice.

Rectal sensation can be assessed by rectal barostat studies or by syringe-driven balloon distension with the balloon either mounted on the manometry catheter or attached to a Foley catheter. The ability to evacuate is tested by BET, where patients are asked to expel a water-filled balloon attached to a Foley catheter sitting on a commode in privacy.

Conventional and magnetic resonance defaecography (MRD) allow identification of structural rectal abnormalities such as rectocele or enterocele with intussception. Furthermore, they can assess pelvic floor descent and rectal emptying of applied contrasts. MRD has the advantage of not exposing the patient to radiation and of giving detailed, dynamic information on the surrounding pelvic floor anatomy.

However, none of the diagnostic tests currently available provide a complete and comprehensive assessment of the complexity

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of anorectal function. Guidelines recommend a series of tests for the diagnosis of anorectal disorders such as FI and FDD after thorough clinical assessment [13, 14].

Management of FI and FDD includes diet modification, medication, and pelvic floor physiotherapy. Biofeedback is effective in FI and FDD.

This review will explore the role of high-resolution anorectal manometry (HR-ARM) for the diagnosis of functional anorectal disorders with a special focus on FI and FDD.

## What Is High-Resolution Anorectal Manometry?

The introduction of HRM utilizing a higher number of closely spaced, circumferential pressure sensors with data presented as colour-contour plots has revolutionized the field of gastrointestinal motility [11]. In contrast, conventional manometry measures pressure only at certain points within the anal canal and presents pressures as trace lines. Even though ARM remains the most frequently performed test of anorectal sphincter function and recto-anal coordination, application and uptake of the high-resolution technology in the anorectum has been slow in comparison to oesophageal manometry, where a validated classification system of motility disorders based on the high-resolution technology has been established [15]. Current guidelines for ARM mainly focus on conventional manometry and are based on expert consensus [16–18].

For HR-ARM, several technologies and catheters with different sensor designs by various manufacturers exist. In two-dimensional HR-ARM, pressure is recorded by flexible catheters with circumferential or unidirectional sensors at different levels of the anorectum. Data are usually presented as an average of measured pressures. Three-dimensional HR-ARM (3D-ARM), also referred to as high-definition ARM in the literature, utilizes a rigid probe with data measured with 256 circumferential pressure sensors. Recorded pressures can be presented either two- or three-dimensionally.

All HR-ARM catheters have sensors at their tip for assessment of rectal pressure. However, the design of rectal sensors is different from those placed in the anal canal in most catheters. Furthermore, the rectal sensors are generally covered by a non-latex balloon, which impacts on the validity of measurement of rectal pressures [19].

## HR-ARM in the Assessment of Faecal Incontinence

FI afflicts all age groups and sexes. Its prevalence is highest amongst middle-aged and elderly women and nursing home residents [20, 21].

FI is characterized by the symptoms urgency, faecal leakage, and involuntary loss of stool or flatus. ARM can provide information on the function of the internal anal sphincter (anal resting pressure) and the external anal sphincter (pressure during voluntary squeeze effort). When it comes to the assessment of sphincter pressures by ARM, differences between healthy volunteers and FI patients exist. Several studies were able to demonstrate an association between a low anal resting pressure and symptoms of passive FI; however, sensitivity for this finding is low [22–27]. Low pressure during voluntary contraction has been demonstrated to be associated with urge FI [23, 28].

3D-ARM has the additional feature of visualizing the physiological asymmetry of the anal canal with higher pressures in the posterior proximal and anterior distal parts of the sphincter complex. Furthermore, 3D-ARM can correlate pressure defects with pathology seen on endoanal ultrasound, e.g. in women with postpartum tears. However, normative data in health and disease, as well as validation of the functional impact of pressure defects seen on 3D ARM are still lacking. Therefore, pressure defects seen on 3D-ARM should be verified by further imaging such as endoanal ultrasound [29, 30].

The Functional Lumen Imaging Probe (Endoflip) is a new tool to assess distensibility in the gastrointestinal tract via impedance planimetry. It is currently mainly applied in the oesophagus for guiding treatment in achalasia (Heller myotomy) as well as before and after semifundoplication [31–33].

The use of Endoflip in the anal canal shows higher distensibility in patients with FI when compared to healthy volunteers, regardless of the pathophysiology of FI (sphincter injury vs. fibrosis). When compared to 3D-ARM, Endoflip has shown a large diagnostic overlap of results in a substantial proportion of investigated patients with FI. Similar to HR-ARM, where a subset of patients with symptoms of FI shows normal sphincter pressures at rest and during voluntary effort, Endoflip has detected normal mechanical properties of the anal canal in some FI patients [34, 35]. This finding highlights that continence function is determined not only by absolute sphincter pressures and possibly by distensibility but also by rectal sensation, volume, and compliance [36]. At present, application of the Endoflip technology in the anorectum is limited to research, and it remains to be investigated if results show additional information when compared to HR-ARM.

## HR-ARM in the Assessment of Functional Defecation Disorders

FDD are part of the spectrum of chronic constipation with outlet obstruction: Symptoms include excessive straining, feeling of incomplete evacuation, and digital facilitation of defecation. The prevalence of FDD ranges between 20 and 80% in patients with chronic constipation in the literature [37–39]. As a symptom-based diagnosis cannot rule out other causes of chronic constipation from FDD, physiological testing is required for diagnosis.

The Rome IV criteria for FDD require fulfilment of diagnostic criteria of functional constipation and/or IBS with constipation for at least 3 months. The inclusion of IBS with constipation is based on emerging evidence for an association between IBS and pelvic floor dysfunction [40]. A combination of anorectal tests, such as manometry, balloon expulsion, imaging via conventional defae-

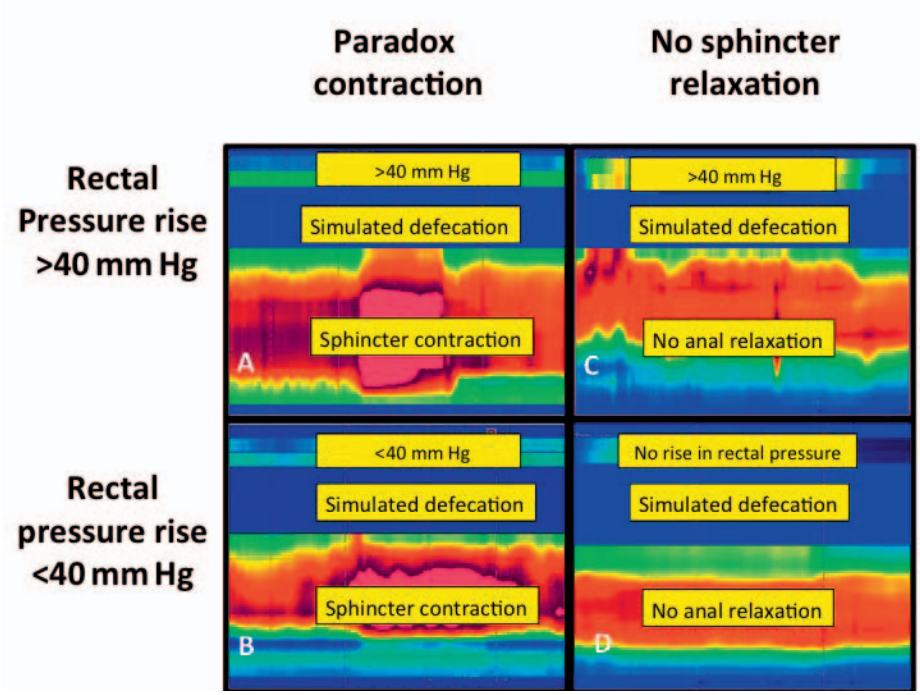


**Fig. 1.** Manometry patterns for dyssynergic defecation according to Rao. **A** Rao type I: Paradox anal sphincter contraction with a significant increase (>40 mm Hg) in rectal pressure during simulated defecation. **B** Rao type II: Paradox contraction with no increase (<40 mm Hg) in abdominal pressure during attempted defecation. **C** Rao type III: No paradox contraction but also no sphincter relaxation is seen. There is an increase (>40 mm Hg) in rectal pressure during simulated defecation manoeuvre; however, it is less than anal sphincter pressure and not sufficient to drive defecation. **D** Rao type IV: No contraction or relaxation of the anal sphincter and no significant increase in rectal pressure during simulated defecation. If this is seen with a lack of sphincter contraction during voluntary squeeze, pelvic floor akinesia is present [47, 52]

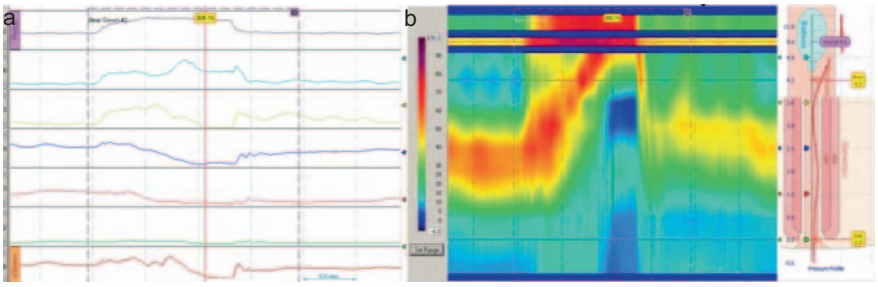


**Fig. 2.** Simulated defecation manoeuvres on **a** conventional anorectal manometry and **b** high-resolution anorectal manometry (HR-ARM). HR-ARM shows that relaxation in the anal canal is actually caused by catheter movement out of the anal canal.

cography or MRD or surface electromyography, are generally recommended to detect anorectal dysfunction during attempted defecation.

High anal pressures can be detected by ARM in constipation and also in the presence of anal fissure, and exact cut-offs for anal hypertonia are lacking [41–44].

While pressures measured by AMR in constipation are not sensitive and specific, 'defaecatory forces' and deficient recto-anal coordination, particularly *inadequate defaecatory propulsion* (impaired rectal force during simulated defecation) and *dyssynergic defecation* (paradoxical anal sphincter contraction during simulated defecation), can be described by manometry in FDD. DD can be further subclassified using the Rao classification (fig. 1).

Data regarding the performance of HR-ARM in detecting different types of DD are conflicting: In conventional manometry, a normal simulated defecation manoeuvre is generally marked by an increase in rectal pressure and a decrease in anal pressure, which is described as anal relaxation in the literature [45]. Paradoxical contraction (i.e. sphincter contraction during simulated defecation), as seen in FDD, is characterized by an insufficient increase in rectal pressure and/or an increase in anal pressure (fig. 2). It has been shown that, due to the larger spacing of sensors in conventional manometry, the actual movement of the catheter during simulated defecation is not being taken into account. When simulated defecation manoeuvres were compared in the conventional and high-resolution mode, a significant proportion showed catheter movement on conventional manometry, which would have led to a finding of false-positive anal relaxation on conventional tracings. Therefore, HR-ARM should actually facilitate data acquisition and interpretation during the simulated defecation manoeuvre [46].

Additionally, in comparison to MRD, a high diagnostic accuracy to detect dyssynergia has been reported in some studies [47]. However, other studies have described a high frequency of DD patterns also in healthy persons [48, 49]. This is limiting the clinical utility of ARM for the diagnosis of DD until further quantitative metrics are developed and validated, and could lead to a high rate of false-positive results in the diagnosis of FDD based on ARM [47, 50–52].

A new manometric pattern termed pelvic floor akinesia, i.e. lack of pelvic floor movement on simulated defecation and voluntary effort, is emerging, with high sensitivity and specificity for poor evacuatory function [52].

Whether the overall low diagnostic accuracy of ARM in this setting can be attributed to the awkward nature of the investigation and non-physiological left lateral test position has still not been sufficiently investigated. Unpublished data show that patients pre-

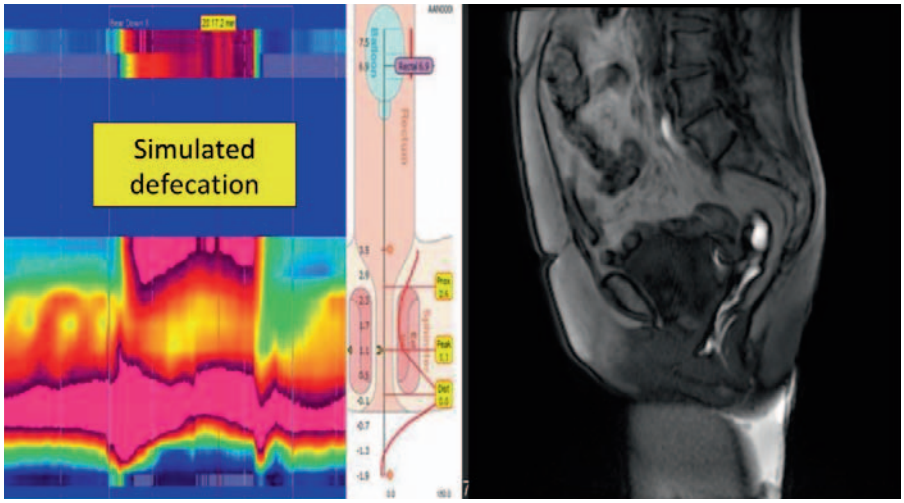


**Fig. 3.** Structural outlet obstruction observed on high-resolution anorectal manometry and magnetic resonance imaging. Note a localized, high-pressure band at the level of the anal sphincter during simulated defecation, clearly different from voluntary contraction (squeeze). Magnetic resonance defaecography shows a rectocele with intra-anal intussusception [47].

fer investigation in the sitting position instead of the left lateral position, in which most tests of anorectal function are performed [53]. When measured in the sitting position, resting pressure is lower and fewer healthy volunteers and patients show a pattern of DD, possibly due to more physiological defecation mechanics with higher abdominal pressures [53, 54].

It can be further argued that the simulated defecation manoeuvre is performed with an empty rectum, driving the catheter into the wall of the anal canal during attempted defecation and causing a picture of contraction rather than of relaxation. Further studies investigating anorectal pressures with HR-ARM with a filled rectum in the sitting position are warranted.

For the diagnosis of structural reasons for constipation, such as rectocele or enterocele with intussusception, HR-ARM and 3D-ARM allow the identification of pressure phenomena not previously identified by conventional ARM (fig. 3). 3D-HRM can give an impression of the amount of pelvic floor descent [55]. Furthermore, recent studies have demonstrated that HR-ARM and 3D-ARM have a high positive predictive value for the presence of an intra-anal intussusception diagnosed by defaecography and MRD [47, 56] (fig. 3). In patients with evacuatory dysfunction, these manometric patterns can be a useful tool to detect structural pelvic floor abnormalities and help to direct further investigations, such as defaecography, and guide treatment.

## Functional Anorectal Pain

The prevalence of functional anorectal pain is estimated to range between 8 and 18%, with both sexes being equally affected across almost all age groups in the community [57].

The *levator ani syndrome* is generally defined as a chronic or recurrent dull ache high in the rectum over a time frame of 3 months. Symptoms usually last 30 min or longer and digital rectal examination reveals tenderness during traction on the puborectalis. *Unspecified functional anorectal pain* is defined by the same criteria as the levator ani syndrome with the exception that there is no local pain during digital rectal examination on traction of the puborectalis [1, 58]. In contrast to the levator ani syndrome, *proctalgia fugax* is defined as recurrent but inconsistent episodes of gnawing, aching, or cramping rectal pain not associated with defecation over 3 months. Episodes can last from seconds to a maximum of 30 min, interrupt activities, and wake patients from their sleep [1].

For the diagnosis of all forms of functional anorectal pain, other causes including inflammatory bowel disease, fissures, thrombosed haemorrhoids, and prostatitis must be ruled out in the first step. Important overlaps exist between the levator ani syndrome, unspecified functional anorectal pain, and proctalgia fugax [1].

Diagnosis is mainly clinical, and evidence for the diagnostic utility of manometry is scarce. With regard to levator ani syndrome, several reports using conventional manometry indicate higher anal sphincter pressures as well as typical manometric patterns of DD. Improvement of symptoms with biofeedback therapy supports the validity of these observations [58–60]. Currently, no data exist on the role of HR-ARM in the assessment of functional anorectal pain, and it remains to be investigated if results seen on conventional manometry are transferable to HR-ARM.

## Current Limitations

Interpretation of the findings of ARM is still challenging due to the wide variability of manometric measurements in health and disease. Recent studies have shown that in spite of its wide application, striking variability in practices between institutions exists when it comes to protocol, equipment, and metrics applied for analysis [61].

Furthermore, existing normative data sets need to be extended to take into account age, sex, parity, and gender [26, 48, 49, 62–75]. Lack of standardization for interaction of the investigator with the patient and feedback during the investigation also increase variance of reported normal values and possibly the rate of DD seen with ARM [65, 68].

Catheter configuration (water-perfused vs. solid-state design) and diameter, sensor configuration of HR-ARM solid-state catheters (unidirectional vs. multidimensional), and sensor density (3D-

ARM vs. HR-ARM) also impact on measurements. Strikingly, usage of a high-resolution solid-state catheter with 23 microtransducers, comprising four radially arranged sensors, yielded lower values (20 mm Hg) for resting pressure and maximum squeeze pressure than another solid-state catheter with 10 pressure sensors with 36 circumferentially oriented, pressure-sensing elements [70]. When looking at another normative data set based on data acquired by a catheter with 12 microtransducers, measuring circumferential pressure by means of unidirectional pressure sensors embedded in silicone gel, these values are significantly higher than those reported by the two other catheters [65]. Even though experimental variability and epidemiological differences in investigated volunteers might partially explain these differences, it is evident that application of catheter-specific normal values is crucial due to differing sensor design and sensor density to assess anorectal dysfunction correctly.

Furthermore, the presence or absence of a stimulus for defecation may have a significant impact on absolute values reported [76–81].

## Conclusion

ARM is a safe and widely available test accepted by patients and doctors. HR-ARM and 3D-ARM are promising new tools in the diagnosis of functional anorectal disorders. HR-ARM can – in combination with further tests of rectal sensitivity and evacuation – provide important information on pathophysiology and guide further treatment. Its ability to visualize subtle pressure changes in the rectum and anal canal during voluntary squeeze effort and simulated defecation provides a clearer depiction of anorectal pressure phenomena. However, actual evidence on usability, consistency, and clinical utility is still lacking, and the impact of this new technology on clinical diagnosis and therapy of FI and FDD needs to be further investigated.

## Disclosure Statement

Both authors report no conflicts of interests.

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